Method of Using the Earth Mantle Substance for Hydrogen Production

Field of Invention

The invention is devoted to production of cheap and effective energy resources, in particular hydrogen, which is used as energy carrier for power industry and transport.

Previous State-of-Art

One of the well-known methods of hydrogen production assumes application of deep high-thermal waters in the places of underwater volcanic activity for power production, supplied for water electrolysis, which results in hydrogen produced (see SU 1624162 МПК Кл.5 E21C 45/00, published 30.01.1991). Another method assumes a supply of powdered aluminium or aluminum hydride and aqueous medium to a reactor and their further interaction. Before the reactor stage, powdered aluminum or aluminum hydride should be coated by water-miscible polymer film based on solution of polyethylene oxide in diethylene dioxide or methyl hydroxide; meanwhile in order to provide a layer-by-layer combustion of metallic materials with hydrogen release, the procedure should be performed at the pressure at least 22,12 MPa and temperature over 647.3 K (see RU №2165388, МПК Кл. C01B 3/06).

Another method assumes an ecologically safe chemical fuel production with reactions of low temperature nuclear fusion in nuclear reactor. Nuclear reactor waste products and deuterium are used as initial agent to produce neutrons. As nuclear fusion is performed, the agent captures the slow neutrons radiated; the released nuclear energy is transformed into electricity, which is applied for water electrolysis to obtain hydrogen and oxygen (see RU № 2180366 МПК Кл. C25B 1/04, published on 03.10.2002).

Another method assumes using the Earth mantle substance to produce hydrogen. This includes an exploration of continental and oceanic rifting areas, supported by abnormal mantle diapers with mantle substance fingers outward to the Earth's crust, the mantle substance well drilling, well water supply inflow, and then hydrogen gas extrac-

tion out of the well. The hydrogen gas is obtained via reaction of water with intermetallic compounds (silicides) and alloys of Si, Mg, Fe (silicon, magnesium and ferrum) that exist in the mantle substance. (see Chemistry and Life No.10, 2000, pp.46 – 51).

The well-known methods are characterized by complicated equipment requirements, significant energy cost due to high power consumption for aluminium production and additional energy consumption for polymers production; high pressure and temperature maintenance, high danger of radioactive environmental pollution around the production place, relatively low efficiency and, as a result, high energy consumption values comparable to energy consumption required to obtain hydrogen by most conventional methods, for example, water electrolysis.

Disclosure of Invention

This invention is devoted to a task of increasing an economic efficiency of hydrogen power industry and reduction in specific energy consumption connected with hydrogen production.

The specified technical result is achieved in the following way: according to the invention, a reaction cavity area should be formed at the well inlet to the mantle substance, hydrogen release is controlled by change in water volume in reaction cavity, meanwhile the reaction cavity surface, involved in reaction, should be regenerated periodically; this should be implemented basing on the well-known method of hydrogen production using the Earth mantle substance, which includes exploration of continental and oceanic rifting areas, supported by abnormal mantle diapers with the mantle substance fingers outward to the Earth's crust, the mantle substance well drilling, well water supply inflow, and then hydrogen gas extraction out of the well, which is generated via water reaction with intermetallic compounds of the mantle substance.

This combination of features provides technical result in all situations, on which the required extent of right protection is spread on. In particularly, the reaction cavity formation allows to obtain a wide surface of water contact with the mantle substance and, consequently, to increase hydrogen generation. Periodical regeneration of the reacting surface allows to keep this surface in reactive condition and even enlarge it. Therefore, hydrogen output is increased while constant energy consumption for well drilling, water supply etc., which results in a decrease of specific energy consumption for hydrogen production.

In particular cases (in specific configurations or special conditions), the invention is characterized by the following features:

Well drilling is performed with help of turbodrills.

An additional well is drilled, and reaction cavity is formed by linkage of the main and additional wells.

The reaction cavity is formed by reaming the main and/or additional wells.

Well reaming is performed by a blast of explosive materials.

The reaction surface regeneration is performed by high-pressure water flow.

High-pressure water flow is supplied through nozzles, installed in reaction cavity, at remotely controlled manipulator system.

A separator is installed in the well or at the well outlet to divide generated hydrogen gas and water vapors.

Heat energy, discharged during hydrogen production, can be utilized.

The Best Version of Invention Realization

According to this invention, hydrogen production using the Earth mantle substance is arranged in the following way.

An exploration of continental and ocean rifting areas is performed by modern methods of exploration and soil investigation, for example, airspace-based. The rifting areas, supported by abnormal mantle diapers, are selected among the found areas. The rifting areas can be considered as the most perspective for hydrogen production, if supported by abnormal mantle diapers with mantle substance fingers that come out into the Earth's crust at the depth of 3-5 km (up to 10 km). According to development of the deep drilling and ultradeep drilling methods, this depth can be increased.

Since the perspective areas are determined, the sites for drilling equipment installation should be prepared. If an ocean rifting area is considered as perspective one, the offshore drilling platform is installed. After preliminary work is finished, at least one well should be drilled into the mantle substance, which is based on rotary drilling technology, for example, by turbodrills, or hydraulic rotary drilling technology.

A drill stem trip is performed with extended "stalks" during maximal extent of process mechanization and automation. Drillings removal is performed by drilling mud circulation. Water-based solutions are used as drilling mud fluids at starting of a well installation. When temperature in the well raises from 240^0C up to 300^0C, it should be changed by application of oil-emulsion solutions, and if over 300^0C the oil-based solutions are applied. Depending on specified geologic and technical conditions, drilling heads of rolling or abrasive types are used.

As far as drilling advances, the stability of rocks at well bores, in conditions of rock and reservoir pressure, should be achieved by maintenance of a required back-pressure in drilling mud column and its quality; and if encountered the low pressure reservoirs, the well bore should be cased by casing string and cemented.

The most preferred option should be that one, when several wells, main and additional, are drilled, one of which can be used to supply water, i.e. as injection, and others are used as production ones, by which reaction hydrogen produced is discharged to the surface. After wells inlet into the mantle substance, the bores are freed from drilling mud fluid, and a reaction cavity is formed, where a reaction of water with intermetallic compounds, included in the mantle substance, and hydrogen release are performed. Application of salt water (for example, sea water) increases reaction kinetics.

A reaction cavity can be formed by injection and production wells linkage and by injection and/or production wells reaming. In its turn, well reaming is possible to perform by explosion of explosive material, lowered down to the well bottom.

The wellhead equipment is installed to provide injection and production wells heads sealing, and flow distribution and control of injected water and correspondingly produced hydrogen. Tubing string heads, casing heads, check and control valves are installed as wellhead equipment.

Then water is supplied into the equipped injection well, and hydrogen gas, which is a result of the reaction of intermetallic compound with water, is brought to the surface through equipped output production well. To direct the produced hydrogen into the production well, the water supply well bore should be sealed at the wellhead and right before reaction cavity interfacing linkage, providing only water pass. In this case, hydrogen, produced in reaction, will be released through the production well opened at the surface.

The production well can also be equipped by vacuum units, which reduce pressure in the production well bore. In this case, hydrogen, produced in reaction, will be released through the production well under the influence of pressure reduction.

The quantity of produced hydrogen (hydrogen output) is controlled by change of supplied water volume and, according to this, by change of reaction cavity water volume. This control can be performed, for example, by decrease of check valves flow profile at the production wellhead and decrease of returned water flow at its constant supply rate to the production well. As a result, the quantity of water, reacting with intermetallic compounds in the reaction cavity, increases, and hydrogen output increases consequently.

The requirement of increase or decrease of the quantity of reaction cavity water is considered according to the quantity of hydrogen release.

A surface, which is involved in reaction, is regenerated periodically as far as intermetallic compounds oxidize. The specified surface regeneration is performed, for example, by high pressure water flow. High-pressure water flow is supplied through nozzles, installed in reaction cavity, at remotely controlled manipulator system. Oxidation products are removed from the reaction cavity by supplied water flow and brought to the surface, where they can be utilized.

A separator can be installed in the production well to divide generated hydrogen gas and water vapors.